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Ecosystem Responses to Nitrogen Deposition in the Colorado Front Range

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ABSTRACT

We asked whether 3–5 kg N y^{21} atmospheric N deposition was sufficient to have influenced natural, otherwise undisturbed, terrestrial and aquatic ecosystems of the Colorado Front Range by comparing ecosystem processes and properties east and west of the Continental Divide. The eastern side receives elevated N deposition from urban, agricultural, and industrial sources, compared with 1–2 kg N y^{21} on the western side. Foliage of east side old-growth Englemann spruce forests have significantly lower C:N and lignin:N ratios and greater N:Mg and N:P ratios. Soil % N is higher, and C:N ratios lower in the east side stands, and potential net N mineralization rates are greater. Lake NO_3 concentrations are significantly higher in eastern lakes than western lakes. Two east side lakes studied paleolimnologically revealed rapid changes in diatom community composition and increased biovolumes and cell concentrations. The diatom flora is now representative of increased disturbance or eutrophication. Sediment nitrogen isotopic ratios have become progressively lighter over the past 50 years, coincident with the change in algal flora, possibly from an influx of isotopically light N volatilized from agricultural fields and feedlots. Seventy-five percent of the increased east side soil N pool can be accounted for by increased N deposition commensurate with human settlement. Nitrogen emissions from fixed, mobile, and agricultural sources have increased dramatically since approximately 1950 to the east of the Colorado Front Range, as they have in many parts of the world. Our findings indicate even slight increases in atmospheric deposition lead to measurable changes in ecosystem properties.

Key words: nitrogen; Rocky Mountains; Colorado; subalpine forests; alpine and subalpine lakes; paleolimnology; diatoms; N isotopes.